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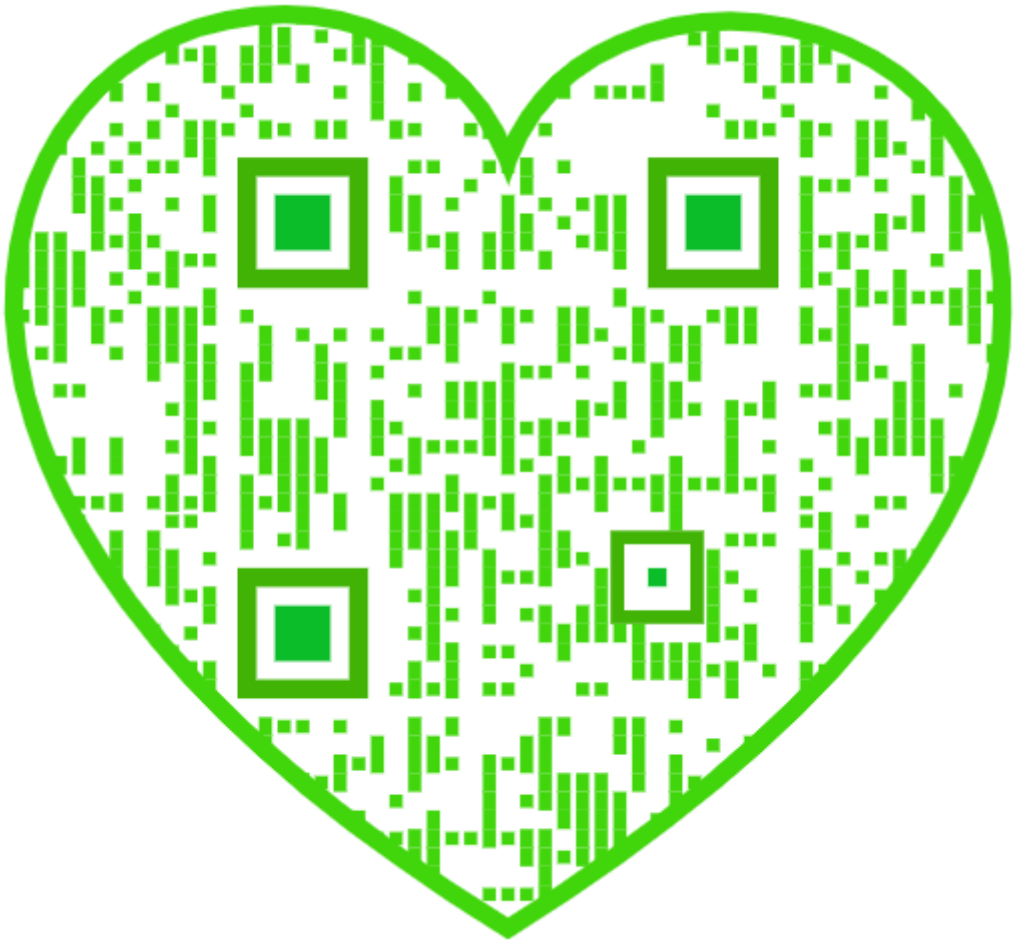
THE FIRM OF

JOHN DICKINSON

AND COMPANY

LIMITED



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THE FIRM OF

JOHN DICKINSON

AND COMPANY

LIMITED

WITH AN APPENDIX ON ANCIENT PAPER MAKING

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LONDON
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PREFACE.

THE primary object of this little sketch is to give a practical response to the repeated requests of members of the Staff serving in India and the Colonies, as well as the wishes of many friends at home and abroad for a publication of this nature. It is sought by this means to acquaint them with the extent and variety of our productions, and so tend to kindle an interest that springs from a closer knowledge of the history and traditions of the Firm.

Mr. Lewis Evans, in preparing the account of the Mills, has been mindful of the necessity of not wearying the reader too much by incursions into the labyrinth of purely technical details.

If a perusal of the book accomplishes the ends we have in view we shall not only have attained our wishes, but, so to speak, justified a step which in our business is at least unique.

The Firm of
John Dickinson & Company,
Limited.

TO all the members of a long established firm, the history of its origin, rise, and progress is always replete with interest. It is, however, very doubtful how far the general public, except in very special cases, will care to hear any details relating to merely a single business, even if it be one of those which for many years have stood in the foremost rank of some great industry. Nevertheless the history of these private enterprises is very closely connected with that of the stupendous advance in material prosperity, and in every branch of manufactures and commerce, which within the space of the last hundred years or so, has raised Great Britain to the position which she now occupies among nations, a position which we all trust she may, for centuries to come, be still permitted to retain.

The firm of JOHN DICKINSON AND CO. (now limited), to which the present memoir relates, has for many years traded in the city of London as a house of wholesale stationers, owning various paper mills and factories in the country in which cards, envelopes, and other articles manufactured from paper are produced.

The founder of the house, John Dickinson, was the eldest son of Captain Thomas Dickinson, R.N., and Frances, his wife, whose maiden name was De Brissac.—The De Brissacs were of pure French extraction, and, as Huguenots, had been compelled to emigrate at the end of the seventeenth century, on the Revocation of the Edict of Nantes. As with so many of the mechanicians, inventors, and men of science in this country, John Dickinson, therefore, had a strong infusion of the best French blood in his veins. He was born on March 29th, 1782, and after passing through the ordinary course of education at private schools, was apprenticed as a stationer to Messrs. Harrison and Richardson. In making choice of a profession the fact that Mr. Andrew Strahan, who at that time held the office of Queen's Printer, was one of the most intimate friends of his parents had, no doubt, considerable weight. The business of a wholesale stationer was in those days very different from what it is at the present time. Paper, instead of being run off in continuous rolls at the rate of 100 or 200 feet per minute, was made by hand, sheet by sheet. There were then no railways, penny post, electric telegraphs or telephones; and as the paper mills were scattered over all parts of the country, most of them in secluded rural valleys, the stationer who relied on a number of mills for the paper which he sold passed much of his time on the top of coaches, in his gig, or on horseback, going from mill to mill, to give orders, and to see that those orders were duly executed.

65, OLD BAILEY, LONDON, E.C.

In 1806, Mr. Dickinson commenced business in Walbrook, having entered into partnership with Mr. George Longman, who for some time represented the borough of Maidstone, one of the centres of the paper-making industry, in Parliament. Shortly afterwards, the house of business was transferred from Walbrook to 65, Old Bailey, where it still remains. It was not, however, long before Mr. Dickinson perceived the desirability of having a paper mill of his own, so as in some measure to be free from the anxiety of having to confide to others the execution of any special orders that he might receive.

Accordingly, in 1809, aided probably by Mr. Strahan, he purchased Apsley Mill, near Hemel Hempstead, in Hertfordshire, and there commenced the manufacture of paper on his own account. He had already shown the inventive turn of his mind by producing a new kind of paper for cannon cartridges, which, unlike the paper ordinarily in use, did not smoulder, and thus obviated a constant source of danger from accidental explosions. For this he obtained letters patent in November, 1807, and the new paper proved of immense value during the Peninsular War, and the Waterloo campaign.

There were, moreover, other inventions which were being gradually developed in his fertile brain, and which he was anxious to put into practice. The idea of the continuous manufacture of paper by machinery instead of by hand was "in the air," and in 1806, Henry Fourdrinier took out the first patent for a machine for manufacturing paper of an indefinite length. This was founded on Gamble's invention of 1801, but was not at first successful. Eventually, however, an improved machine was erected, and set to work at Frogmoor Mill, on the same stream —the Gade—as Apsley Mill, and immediately above it. The

Fourdrinier idea was to pour the diluted pulp, from which the paper was to be made, upon a horizontal portion of an endless web of wire which was constantly moving forward. A shaking motion, in imitation of the movements of the "vatman," who made sheets of paper in a mould by hand, was imparted to the wire, and after the greater part of the water had drained away through the woven wire, and the newly-born film of paper was partially consolidated, it was finally pressed between a pair of rollers, one under and the other above the web of wire, and wound on a reel before being carried away to dry.

Mr. Dickinson conceived a totally distinct system of manufacture, in which, however, he had to some extent been anticipated by Joseph Bramah, the inventor of the hydraulic press. In his process, which was patented in 1809, and in an improved form in 1811, an ingeniously constructed perforated cylinder of metal, having a closely fitting cover of finely woven wire, was made to revolve in a vat filled with pulp, the water from which was carried off through the axis of the cylinder, leaving the fibres of the pulp on the surface of the wire in the form of a continuous sheet of paper, which was carried off by means of an endless web of felt passing round what was known as a "couching roller," that lay upon the cylinder. As the web of paper emerged from the pulp, it was consolidated by suction, a partial vacuum being maintained within a portion of the cylinder by means of an air-pump.

The advantages of the Dickinson machine over the other form were principally the comparatively small degree of wire-mark in the paper, the consequent resemblance in the surface of the two faces, and lastly, the satin-like character which resulted from a large proportion of the fibres being laid in the same

direction, viz., that in which the cylinder revolved. The air-pump has now for many years been applied to the Fourdrinier machine, and recent improvements have done much to equalize the productions of the two forms of machine, but for many years the paper made on the Dickinson system carried the palm among the printers who wished to have justice done to their type, ink, and woodcuts. A modified form of the machine is still extensively used in the United States of America.

While residing at Apsley Mill, Mr. Dickinson became acquainted with Miss Ann Grover, the daughter of a solicitor and banker at the neighbouring town of Hemel Hempstead, to whom he was married in 1810, and by whom he had a numerous family, of whom, however, only three, a son and two daughters, arrived at maturity.

A few years after the acquisition of Apsley Mill, Mr. Dickinson was able, in 1811, to purchase the adjoining Nash Mills, which are situate about half a mile lower down on the same stream, and have a considerably larger amount of water power. A mill existed on the spot at the date of Domesday Book, which subsequently became the property of the abbots of St. Albans, and is mentioned in one of the chronicles of the abbey under the name of "Asschemulle."

In the comfortable dwelling-house attached to Nash Mills Mr. Dickinson resided for many years, introducing into the manufacture of paper numerous improvements, and gradually enlarging the sphere of his operations. He was not, however, free from anxieties, and early in 1821 he had to contend with a strike among those employed in the mills. With his usual determination he made short work of the matter, discharging all those who were discontented with their position, and filling the

vacant posts with the ordinary labourers of the neighbourhood. These, in an incredibly short time, he was able to train to efficiency in their new avocations, as the whole process of making paper by machinery had grown up under his care and guidance, and he was at home in every detail of the work.

As has been so frequently the case with other industries, the introduction of machinery for the manufacture of paper led to a great discontent among the workmen engaged in the old process of making paper by hand, and this discontent culminated in violence. About 1830, in the days of the "Swing" riots, a large gang of machine breakers marched upon Nash Mills from the neighbouring county, Bucks, intent upon destruction. Fortunately, they were met by a party of foxhunters, members of the Old Berkeley Hunt, in pink, and the rioters, mistaking these for soldiers, thought that discretion was the better part of valour, and dispersed. Had they arrived at Nash Mills they would have found the place in perfect readiness to give them a warm reception, a complete system of defence having been organized, under the direction of General Beckwith, an old Peninsular officer, who was staying with Mr. Dickinson at the time.

Another difficulty with which Mr. Dickinson had to contend was the necessity of defending the water-rights of his mills at law. The Grand Junction Canal, as originally constructed, ran in a channel of its own, distinct from that of the River Gade, from above Apsley Mills to below Nash Mills, where it joined the river, after passing through a series of locks. This portion of the canal seems to have been badly constructed, and to have been constantly losing water, and to make good this loss the company abstracted water from the river, thus injuring the

water-power of the stream. Action after action for the damage that ensued had to be brought by Mr. Dickinson against his powerful neighbour, until an intimation from the Court made the company perceive that an end must be made of their illegal abstraction of water. They then agreed that the course of the canal should be changed, and that the bed of the river and of the canal should, near the two mills, be, so far as possible, one and the same. Mr. Dickinson, with his usual energy, undertook the contract for carrying out the work, which involved the construction of at least three new locks.

Not improbably it was these successive lawsuits that directed his attention to the natural laws that regulate the flow of streams in districts lying geologically on the chalk. In those days steam-engines in paper-mills were few and far between, and it was of great importance to be able to foresee whether the water-power that would be available during a coming summer and autumn would be large or small. It was known that the flow of the chalk-streams during these seasons mainly depended upon the rainfall of the previous winter, but Mr. Dickinson was the first to construct "percolation gauges," after the manner devised by Dr. Dalton, and draw practical conclusions from them. If, for instance, twelve or fourteen inches of the rain falling during the winter months found their way through the three feet of soil in the gauge, he knew that there would be a full supply of water in the river during the summer. If, on the contrary, only three or four inches passed through the gauge, he knew that a "short-water time" was certain to follow in due course. The series of observations on percolation at Apsley and Nash Mills has been continued and extended by Mr. Dickinson's successors, and is well known to engineers. It

formed the subject of communications by him both to the Institution of Civil Engineers and to the Royal Society.

These lawsuits also led to his forming the acquaintance of several of the leading counsel of the day, an acquaintance that ripened into friendship which survived long after the advocates had been elevated to the Bench.

His intimate acquaintance with the question of water-supply, as well as his well-known mechanical ingenuity, led to his being elected a Fellow of the Royal Society of London. He was also a Fellow of the Society of Antiquaries, and a member of various other learned societies, as well as of the Athenæum Club.

We must now glance at some of the other inventions connected with the manufacture of paper for which Mr. Dickinson obtained letters patent. One of the most important of these dates from 1817, and related to the manufacture of paper for copper-plate printing by "a process similar to veneering in cabinet-maker's work." Two webs of paper, made on different cylinders, one of very fine material, for the face of the paper, and the other of coarser, for the backing, were united at the machine, and not only a thicker but a better paper for the reception of impressions of engraved plates than any hitherto made by machinery was thus produced. The process is still employed by the existing firm of John Dickinson and Co., Ltd., and in a modified form is largely used in America.

Another invention, patented in 1824, related to the cutting cards by machinery, by means of circular cutters, a process now universally adopted. Under the same patent was a machine for continuous pasting of webs of paper together so as to form card-board or paste-board. This process is also still in use,

though, of course, some modifications in the machinery have been introduced.

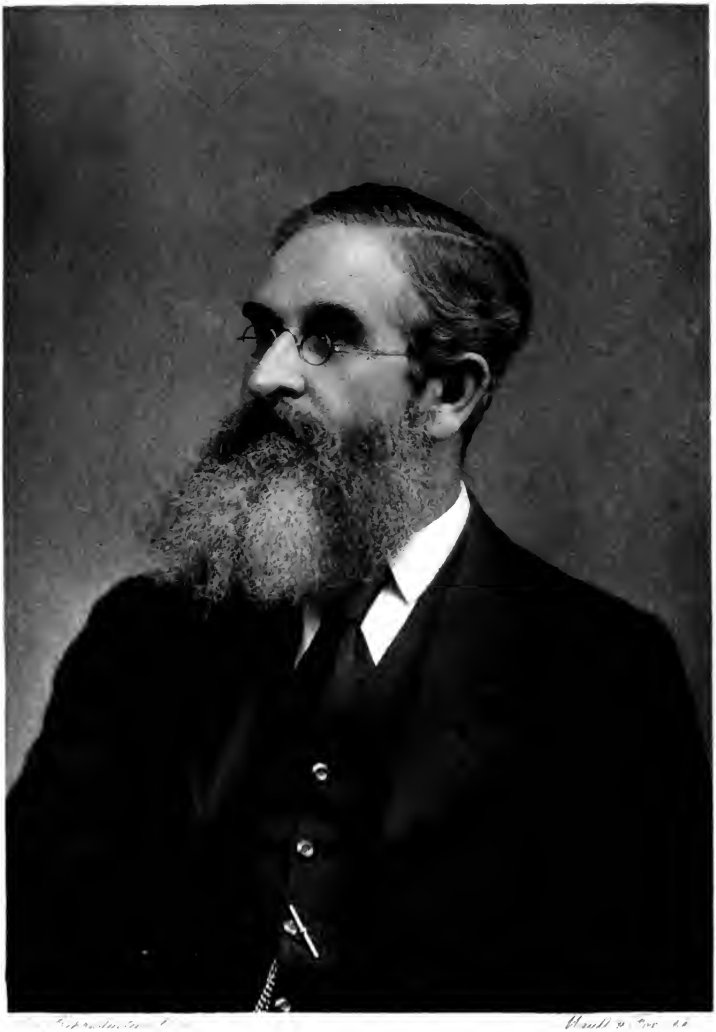
Another of his inventions was a cylindrical knotter or strainer for purifying pulp, which was the precursor of the numerous other forms of revolving knotters that have been in use, and the principle of which has been more than once re-invented. This was patented in 1832.

The production of a paper offering securities against forgery, also occupied Mr. Dickinson's attention, and he devised a process for the introduction of cotton, flaxen, or silken threads into the body of paper, which, though first patented in 1829, was not brought to perfection until ten years later, when it again formed the subject of a patent. On the introduction of the penny post, about 1840, envelopes and flat sheets of note-paper were sold by the Post Office to the public, and, to prevent spurious imitations, the paper was manufactured so that each envelope contained within it two silk threads, one of pink, and the other of twisted white and blue, and each sheet two threads, one blue and white, and the other pink and white. Exchequer bonds were printed on a thicker paper, in the body of which seven or eight threads of coloured silk were imbedded, the arrangement of the colours varying with each issue. The Mulready envelopes and covers, now much valued by collectors, were made of paper of the kind just mentioned.

Of other ingenious contrivances may be mentioned, the application of magnets to the extraction of small particles of iron from the pulp, the process of continuous tub-sizing with gelatine at the machine, and if tradition speaks truly, that of the continuous drying of paper, as made, by a series of cylinders heated by steam.

While devoting so much attention to the mechanical side of paper-making, Mr. Dickinson by no means neglected the commercial aspect, but continually extended his business relations with publishers, among the principal of whom his genial disposition and general intelligence rendered him deservedly popular. He found that to meet the demands of his business it was necessary to extend his powers of production, and in those days, when water-power was valued more than steam, extension meant the acquisition of other mills, rather than the enlargement of those already in his possession. Finding that water-power existed on the Gade below Apsley and Nash Mills, which was not utilized, he succeeded in buying certain lands and water-rights, and Home Park Mills, near King's Langley, and Croxley Mills, between Watford and Rickmansworth, were successively erected, the latter being set to work about 1830, and the former some four or five years previously. Both these mills were provided with machines for the manufacture of paper, and Batchworth Mill, near Rickmansworth, formerly a cotton mill, was purchased and converted into a "half-stuff" mill, where rags and other materials were prepared and "broken in," etc., so as to be ready for conversion into pulp at the other mills. A "half-stuff" mill was also erected at Manchester, where the waste arising from the cotton manufacture was cleansed and prepared as a paper-making material.

While much of this work was going on, Mr. Dickinson had not been entirely single-handed. Mr. Charles Longman, the second son of the late Mr. Thomas Longman of Paternoster Row, came to the mills while Croxley Mill was in process of construction, and became a partner about 1830, devoting himself mainly to the manufacturing part of the business. On his



marriage in 1836, he came to reside at Nash Mills, Mr. Dickinson being at that time engaged in building for himself, and without the assistance of an architect, a new abode on a neighbouring site, to which he gave the name of Abbot's Hill; this mansion he began to occupy about 1839, and it remained his country seat until the time of his decease, when it descended to his only son John, whose eldest son John is now its owner.

In 1840, Mr. John Evans, a son of the Rev. Dr. Arthur Benoni Evans, of Market Bosworth, and a nephew of Mr. Dickinson, came to the mills to learn the business, and in 1850, after his marriage with Mr. Dickinson's younger daughter, he was admitted into partnership, Mr. Frederick Pratt Barlow, who had some years previously married the elder daughter, being admitted at the same time. It was at about this period that the firm had again to defend its water-rights from an attack on the part of the Grand Junction Canal Company, who had sunk a well, "The Cowroast," a few miles south of Tring, and were beginning to pump water from it for the supply of their canal. An injunction from the Court of Chancery to restrain them from so doing was applied for, and after a series of experiments which conclusively proved that the water pumped from the well would otherwise have gone to supply the river by springs, a perpetual injunction against the company was granted.

In another important litigation the firm of John Dickinson and Co. were not so successful. The diminution in the rate of postage naturally led to an immense increase in the number of letters sent through the post, and one of the consequences was a greatly increased demand for envelopes in which to send them. An extremely ingenious machine for the purpose of folding envelopes had been invented by a Frenchman of the name of

Rémond, and his patents were purchased by the firm. After many experiments and much expense, the machines were made a mechanical success, and for a considerable length of time the manufacture of envelopes was carried on without let or hindrance at Apsley Mills, where machinery for the manufacture of writing paper, to be cut up and converted into envelopes, was erected. In the meantime, however, a change had been gradually coming over the application of the Patent Laws, and, encouraged by this, Messrs. De la Rue and Co., who had been first in the field in the manufacture of envelopes by machinery, brought an action for infringement against John Dickinson and Co., and notwithstanding the essential differences in nearly all respects between the machines used by the two firms, Messrs. De la Rue gained the day. Terms were, however, eventually arranged between the disputants, and the manufacture of envelopes at Apsley Mills has continued to grow and prosper, and now forms the principal branch of employment there. Another important branch is the manufacture of cards, which was commenced about 1820. The production of cards for use in the Jacquard Loom employed, and still employs, a large amount of labour, the special feature of the cards being their insusceptibility to change in length from atmospheric influences. Owing to the delicate nature of the machinery of these looms any variation in the length of the cards leads to much trouble and loss ; some of the needles by which the pattern in the woven fabric is produced having to pass through corresponding holes in the cards each time that the shuttle crosses the loom. Large quantities of visiting cards, show cards, paste-boards, and mounting-boards are also manufactured at Apsley Mills.

At Home Park Mills was introduced the process of surface-

colouring and enamelling paper and cards. At first this was done by hand, and a considerable manual training was necessary for learning the art. Much of the colouring is now effected by machinery, on continuous webs of paper, which are afterwards calendered and cut into sheets at other machines.

It was in connection with the card and colouring departments that branch establishments were started about the year 1842 at Nottingham, and a few years afterwards at Belfast. At these, not only were the loom cards for the lace and linen manufactures on sale, but also cards on which to wind the lace, and bands of coloured paper in which the webs of linen were wrapped, while fancy boxes for the purposes of both manufactures were made upon the spot. That at Belfast is still continued by the firm.

Besides these two establishments there was an agency at Leeds, both for the sale of loom cards and the purchase of the hemp and flax waste from the spinning factories in Yorkshire, which was sent to Batchworth Mills, and there prepared for conversion into paper.

It will, however, now be well to revert for a short time to the personal history of the members of the firm, from which Mr. Dickinson retired in 1859, having attained to the age of seventy-seven. After his retirement he continued to take an interest in public affairs and in literary and scientific pursuits, though from physical causes he was unable to make much use of the fine observatory that he erected at Abbot's Hill. He died at his London house, in Upper Brook Street, on January 11th, 1869, having nearly completed his eighty-seventh year.

On his retirement the partners in the firm were Charles Longman, Frederick Pratt Barlow, and John Evans. Mr. Barlow was principally occupied with the business in London.

Mr. Longman had already, in 1856, made over the residence at Nash Mills to Mr. Evans, and had taken possession of his new house at Shendish, which he had built on an estate that he had purchased on the south side of the valley, between Apsley and Nash Mills, and the principal direction of the manufacturing department fell to the lot of Mr. Evans. Mr. Longman was active as a magistrate and poor-law guardian and was well known in the hunting field. In 1871 he served the office of high sheriff of the county of Herts; but in 1873, in full vigour of life, he died suddenly of heart disease while walking back to his house from a visit to the mills. He left behind him an only son, Mr. Arthur Hampton Longman, who, though for some time interested in the business, never took much part in the actual management.

In 1872, Mr. Frederick Pratt Barlow, junior, and in 1877 Mr. Frank Pratt Barlow were admitted as partners in the firm, both being sons of Mr. Pratt Barlow, who, on Mr. Longman's death, became the senior partner in the concern, and who died while still in the active management of it in 1883.

Mr. Lewis Evans, the second son of Mr. John Evans, became a partner in 1881. Of this younger generation Mr. Frederick Pratt Barlow has already passed away, his death having taken place in 1893, after a long and painful illness. While in health he devoted himself, with much energy, to the expansion in various directions of the business of the concern; and the successful establishment of the Indian branch was mainly due to his efforts, seconded by those of Mr. G. A. James Rothney, the secretary of the existing limited company. In the conversion of the old firm into a limited company, and in the various reconstructions and new arrangements consequent upon it, his

Art Reproduction Co. NY

John Sartain & Co.

Frederick Pratt Barlow

was the ruling spirit. These matters may be considered in subsequent pages, but, before doing so, it will be well to refer to some of the changes in the paper trade which have taken place since 1840 (the year when Mr. Evans joined the business), and the part which partners in the firm of John Dickinson and Co. have taken in the various movements which have agitated the trade.

In 1840 the excise duty of 1½*d.* per pound was levied on all paper, and produced about £1,000,000 annually for the revenue. At the time when the duty was repealed, in 1861, the amount had increased to about £1,400,000. As to the desirability of the repeal of the duty, paper manufacturers were divided in opinion; some regarding the duty as fettering their actions, and others fearing that if it were repealed a door would be opened to unfair foreign competition, and that the differential duty on foreign paper would be abolished at the same time. In those days almost the only materials known as suitable for the manufacture of paper were rags and the waste arising from textile industries, and in all the countries of Europe there were export duties on these materials.

As the paper manufacturers of the United States of America were always in the market, buying rags indifferently in Britain and on the Continent, the prices in each case were equalized, so that manufacturers in France and other countries could always obtain their materials at prices lower than their British competitors by the amount of the export duty. The effect was, in fact, the same as a bounty of fully a penny per pound on the export of foreign paper to England.

Against free trade in paper, unless it were accompanied by free trade in the materials from which paper was made, the

manufacturers in this country were practically unanimous, and the strongest possible efforts were made to retain a countervailing import duty on paper coming from countries where an export duty was levied on rags. In the agitation on this subject the houses of Dickinson, Wrigley, and others, took the leading part, and, though all efforts were unsuccessful, the movement did much to remove that isolation among paper manufacturers that had previously been the rule, and led to the foundation of the Paper Makers' Association and of the Paper Makers' Club, of both of which Mr. Evans was the first president. The usefulness of the Association has been frequently proved when united action of those engaged in the same manufacture has been necessary, while the Club has done much to promote personal friendships among them.

The injurious results that would have ensued from the one-sided Treaty of Commerce with France were fortunately, to a great extent, averted by the introduction of Esparto as a paper-material, by the late Mr. Thomas Routledge, and in France itself the export duty on rags was eventually abolished, mainly through the efforts of the French rag-merchants, which were efficiently supported by Mr. Evans.

When Esparto was first introduced, the processes for the recovery of the soda employed, and for purifying the effluent waters from a mill, were very imperfect, if not unknown, and the danger of contaminating the Rivers Gade and Colne prevented the firm of John Dickinson and Co. from preparing Esparto in Herts, but the members of the firm joined with Mr. Routledge in the establishment of the Ford Works, near Sunderland, where for many years Esparto half-stuff was prepared for consumption at the Hertfordshire mills. However,

in 1877, Frogmore and Two Waters Mills, situated immediately above and close to Apsley Mills, having become vacant, Messrs. Dickinson and Co. took them on lease for seven years, and proceeded to make paper at Two Waters Mill from Esparto prepared at Frogmore, so that at this time they had ten manufactories, containing no less than fourteen paper-machines, all working simultaneously, namely—Batchworth, Croxley, Home Park, Nash, Apsley, Frogmore, and Two Waters Mills, all in Hertfordshire, a half-stuff mill at Manchester, a fancy-box making house in Belfast, and a stationery factory at 65, Old Bailey.

The management and working of these numerous factories was found to be both costly and difficult, and about the year 1885 it was decided to commence the heavy task of concentration, closing some of the mills and developing others, so as to get not only an increased production, to meet the wants of a rapidly growing trade, but also that increase in the most economical way, by the employment of machinery and methods well ahead of those in general use by the paper trade. This was also thought to be a good opportunity for converting the old private business into a private limited company, a scheme which had long been maturing, and was only waiting for the proper moment to come for its completion. With these objects in view, Mr. John Evans, who had been in the business more than forty-five years, decided to retire from its management in July, 1885, and leave to his younger partners the task of conversion and concentration.

Mr. John Evans, now Sir John Evans, K.C.B., was born November 17th, 1823, and began paper-making with his uncle, Mr. John Dickinson, in 1840, and became a partner in the business in 1850, when he married Mr. Dickinson's younger

daughter. He devoted all his leisure moments to science, and in 1849 became a Member of the Numismatic Society, of which he has been President since 1874; a Fellow of the Society of Antiquaries in 1852, and its President in 1885; a Fellow of the Geological Society in 1857, and President in 1876; Fellow of the Royal Society, 1864, of which he has, since 1879, been a Vice-President and the Treasurer. He is also Corresponding Member of the Institute of France, M.R.I.A., F.L.S., F.Z.S., etc. The Universities of Oxford, Dublin, and Cambridge, have conferred on him the honorary degrees of D.C.L., LL.D., and Sc.D., and in 1892 he was created K.C.B. In addition to numerous papers communicated to learned societies he is the author of the following books: "Ancient British Coins," 1864; "Ancient Stone Implements of Great Britain," 1872; "The Ancient Bronze Implements, Weapons, and Ornaments of Great Britain and Ireland," 1881.

Besides devoting so much time to science, he has also taken an active part in county business in Hertfordshire, of which county he was High Sheriff in 1881. He is a J.P., D.L., Chairman of Quarter Sessions, and Vice-Chairman of the County Council.

As a paper-maker, he has always taken an active part in any movements affecting the welfare of the trade, notably in trying to obtain the abolition of the foreign export duty on rags, when the paper duty was abolished in this country.

On March 31st, 1886, the new private company of John Dickinson and Co., Limited, came into being, and acquired the three freehold mills of Apsley, Nash, and Croxley, together with the land, houses, water-rights, and machinery belonging to them, as well as the whole stock of the old firm,

Besides the Hertfordshire mills, and the London house, 65, Old Bailey, there are now branch establishments in Manchester, Bristol, Belfast, New York, Cape Town, Johannesburg, Bombay, and Calcutta, which together more than absorb the large output of the mills, which is now about 200 tons of paper per week, in addition to cards, envelopes, and stationery.

The present capital of the Company is £450,000, divided into £200,000 of 5 per cent. Cumulative Preference Stock, and 250 Ordinary Shares of £100 each, and the Directors are:

FRANK PRATT BARLOW, *Chairman*,
LEWIS EVANS,
CHARLES HOPE LITTLE,
CECIL H. THOMAS,
CAPT. GEORGE WEMYSS,
and GEORGE ALEXANDER JAMES ROTHNEY, *Secretary*.

ERRATUM.

Page 23, second paragraph, *for* "250 Ordinary Shares," *read* "2,500 Ordinary Shares."

CROXLEY MILL.

CROXLEY MILL.

CROXLEY MILL was entirely created by Mr. Dickinson, who, after having obtained a private Act of Parliament to enable him to acquire the site of the mill, to which Act the royal assent was given on June 19th, 1828, and in spite of great difficulties and opposition, at last succeeded in building a paper mill, which commenced working in 1830, and in 1838 was making about fourteen tons of paper a week. This mill continued with little alteration until 1881, when the beater-house and machine-house were rebuilt, and a new machine substituted for one of the old and narrow ones, turbines put in place of water-wheels, and a new steam engine erected. But when in 1886 it was decided that this mill should prepare all the materials and make all the paper that had formerly been made at Two Waters, Frogmore, Apsley, Home Park, Batchworth, and the Manchester Mill, a very comprehensive scheme of enlargement had to be carried out; and having obtained ground for the new works on the Common Moor adjoining the mill, by exchanging land bought for that purpose from Lord Ebury, the alterations were commenced towards the end of the year, and made such rapid progress that

by the end of 1888 Two Waters, Frogmore, and the Manchester Mills had been given up, while Apsley and Home Park Mills no longer made paper, and many of the skilled workmen had migrated from them to Croxley, and were occupying some of the fifty new houses that the Company had built near Croxley Green.

At Croxley Mills are now made all the better kinds of paper, such as tub-sized and engine-sized writing papers; map, lithographic, and plate papers; highly glazed papers for magazines and illustrated journals; and the best papers for printing Bibles and all classes of books.

The principal materials used in their manufacture are rags, esparto grass, and wood-pulp. The actual buildings of the mill cover an area of about 24,000 square yards, or nearly five acres.

The power for driving the machinery is almost entirely derived from steam engines, though there are four American "Hercules" turbines working under a head of 13 ft., which drive the water-pumps, and in wet years help to drive the beating-engines.

The coalshed occupies an area of 200 ft. by 50 ft., and is capable of holding 4,000 tons of coal, the building being a portion of the Camperdown Gallery from the Naval Exhibition. The coal is unloaded from boats on the Grand Junction Canal by a kind of dredging machine, which delivers it to an endless chain-conveyor running in a trough along the top of the shed. There are gratings in the bottom of this trough through which the small coal can drop, the lumps which are too big for the mechanical stokers passing on to the other end of the shed. The chain returns along the shed in an underground tunnel, the coal for the boilers dropping on to it through openings in the floor,

NO. 2 BEATER HOUSE, CROXLEY MILL.

and so being carried along for delivery to a second chain, which conveys it over the mill-tail to the chimney, where it is elevated to a third chain passing along the top of the boiler-house. This chain distributes the coal down shoots to feed the mechanical stokers on the boilers, the ashes and clinkers being carried out of the house by the returning chain. Situated at the foot of the chimney are several Green's fuel economisers, having an aggregate of 1,340 pipes for heating the feed water.

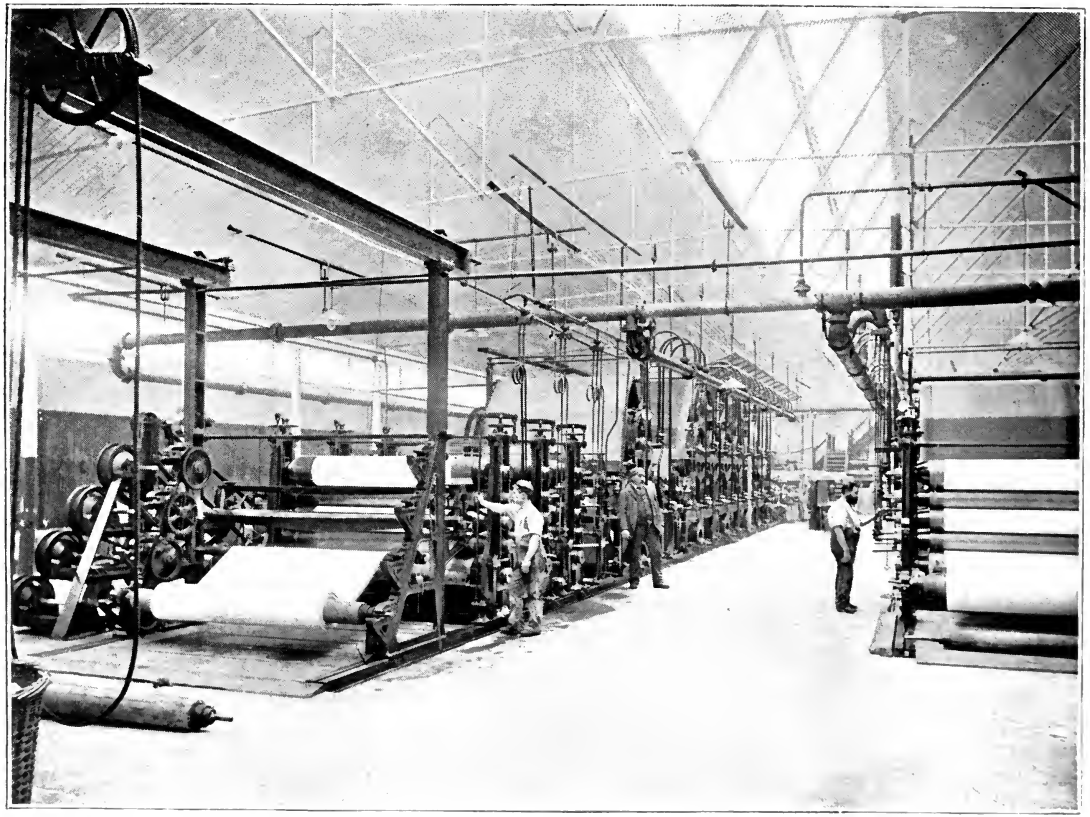
The chimney stands on a block of concrete about 35 ft. square and 15 ft. deep. It has an octagonal base about 15 ft. high, from which rises the circular brick shaft tapering 3 in. in every 10 ft. The total height of the chimney is 206 ft., and its inside diameter is 9½ ft. throughout. Each 10 ft. and 50 ft. is marked by courses of blue brick, and there are hand and foot irons built up outside to facilitate repairs or examination. The cap is of brickwork surmounted by a cast-iron curb, and the chimney is provided with two copper lightning conductors.

Steam for the main engines at a pressure of 150 lbs. per square inch is supplied by eight boilers, of which six are Babcock-Wilcox water-tube boilers of 140 horse-power each; one is a Mills sectional boiler, also of 140 horse-power (this boiler is a combination of a Cornish with a water-tube boiler), and the other, the last added and the best, is a steel Lancashire boiler 8 ft. diameter and 28 ft. long. The steam for driving the smaller engines in the mill, and for boiling the various materials used in it, is supplied at a pressure of 80 lbs. per square inch by nine Lancashire boilers. Each of the seventeen boilers is fitted with mechanical stokers on the sprinkling system of Messrs. E. Bennis and Co., who also supplied the chain coal-conveyors.

Close to the boiler-house, and only separated from it by a roadway, is the main engine-house, containing two triple-expansion steam-engines, made by Messrs. Pollitt and Wigzell, which will together yield 1,800 indicated horse-power. One of these was started in 1888—the first of its type used on land—and the second in 1893. The former has cylinders 16, 26, and 46 in. diameter, and a stroke of 5 ft. 6 in. The high-pressure valves are of the piston type, and the engine makes 75 revolutions per minute, and indicates about 1,150 horse-power, with a steam pressure of 150 lbs. The fly-wheel, 20 ft. diameter by 6 ft. wide, is grooved for rope driving, and weighs with the crank-shaft nearly 60 tons. The power is transmitted by 28 cotton ropes to the steel main-shafting, which runs at 175 revolutions per minute.

The second engine is of the tandem type, with cylinders 14½, 22, and 35 in. diameter, and 4 ft. 6 in. stroke; it is fitted with Corliss valves, and has a speed of 83 revolutions per minute. The fly-wheel is 18 ft. diameter, 6 ft. 6 in. wide, and grooved for 32 ropes. The crank-shaft extends beyond the fly-wheel, so that when required another similar engine can be put in and coupled on to it.

For the rags—the most valuable and important of the materials used in the mill—there are two stores, which cover an area of 120 ft. by 90 ft., and stand at some distance from the other buildings. The tram lines which are carried all round the mill enable the rags to be readily brought into the dusting-house, where the bales are opened and the contents passed through a star-shaped revolving duster, which opens them up and shakes out much of the dust. They are then sorted by women, who take out the buttons, indiarubber, and other extraneous matter. They



NO. 2 MACHINE HOUSE, CROXLEY MILL.

next pass through a Coburn-Taylor cutter, which first cuts them into strips by means of cast-steel disc cutters, and then into square pieces between a fixed plate and a revolving spiral knife, similar to that of a lawn mower. The cut rags are carried forward by travelling belts, and passed through a series of four revolving wire-covered dusters. The dusted rags then pass up a long belt to another building, and fall down shoots into the rag-boilers, which are revolving spherical boilers 9 ft. diameter. After being boiled with soda for some hours, the rags are emptied out to drain on floors of perforated tiles, and are then put through a Malcolm rag-washer, by which they are raked forward from tank to tank, meeting in their course a stream of clean water, and after passing through wringing rolls drop into iron trucks. They are then finally washed, broken in, and bleached in breaking engines or "potchers," from which they can either be emptied direct into the "beaters" or run down as half-stuff into draining chests.

The esparto grass, which is imported from Spain and North Africa as a paper-making material, is stored in four isolated sheds, each 100 ft. by 45 ft., standing close to the canal for convenience of unloading. After being brought into the mill the esparto is passed through a strong conical dusting-machine, and is then taken up by a hay-elevator and dropped into four vertical stationary boilers about 22 ft. high and 8 ft. diameter, each holding 3 tons. In these it is boiled for some hours with strong caustic soda. The boiled grass is then blown out by steam pressure into closed washing vessels, and the dark-coloured liquor, or lye, is run off to the recovery house. The grass is washed by downward percolation in these vessels, and is then mixed with clean water and passed through strainers which hold back the weeds and roots. It is afterwards pumped up into large

cast-iron "potchers," each holding a ton, where it is bleached; or else bleach is added to it, and the mixture pumped through a series of bleaching chests with agitators in them; and the bleached pulp is then passed over the wet end of an old paper-making machine to drain it and bring it into a convenient form for handling.

The lye in which the rags and esparto have been boiled is conveyed in pipes to the soda recovery house, where it is sent first through a multiple-effect Yaryan evaporator, consisting of three or four horizontal cylindrical iron vessels with a series of pipes passing through them. Steam is admitted to the shell outside the pipes of the first vessel, and the lye passed through them, by which means part of the lye is converted into steam, which goes into the shell of the second vessel, whilst the partially concentrated lye is sent through the second set of pipes, and so on until the lye is concentrated from about 5° Twaddell to 40°, that is, from a specific gravity of 1·025 to 1·200. It is then evaporated to dryness and incinerated on brick hearths by direct fires, and the resulting soda ash, or carbonate of soda, from which all the vegetable matter has been burnt, is dissolved in water and made caustic by boiling with freshly-burnt lime; this caustic solution is re-used in the mill. The process described results in the recovery of over 80 per cent. of the soda used, which, if allowed to run to waste, would seriously pollute the river.

The wood pulp, which is prepared in Scandinavia or Germany by boiling small pieces of clean wood (fir or pine) either with caustic soda or sulphite of lime, reaches Croxley in the form of sheets, and only has to be bleached in the potchers and reduced to pulp for use.

There are two beater-rooms in the mill, which join each other and are on the same level. The larger is 180 ft. long and 90 ft. wide, roofed in one space. Besides the ordinary type of beaters, there are in use Umpherston beaters (the first of which was put

"SALLE" NO. 1, CROXLEY MILL.

up at this mill), Taylor beaters, and Jordan and Marshall refining engines, making with the potchers over fifty in all.

There are also two machine-houses, one containing four paper-machines, amongst which is a cylinder machine of the form patented by Mr. Dickinson in 1809. The other house, which is 160 ft. long and 80 ft. wide, has two machines in it, and is connected with the tub-sizing house, containing a drying machine with over

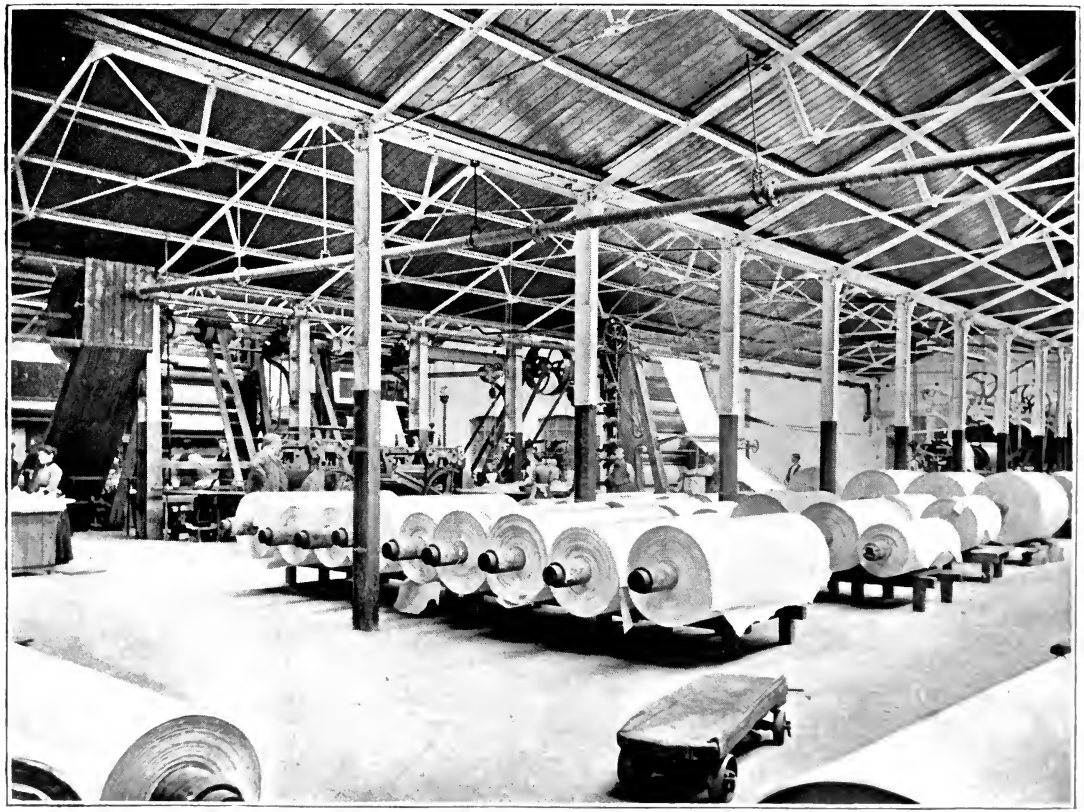
100 drying drums. Between these two machine-houses, and linking them together, is the cutting and calendering house, in which are seven stacks of supercalenders for glazing and burnishing the paper, the rest of the room being filled with plate, glazing rolls, cutting, and winding machines. Adjoining this building are the paper stores and "Salle," or finishing room, the latter 160 ft. long and 45 ft. wide. Beyond these again are the counting-house and office.

The water supply for the mill is obtained from a boring 300 ft. deep in the chalk, but as the hard water soon causes an incrustation to form in the steam boilers, two large water-softeners have been put up, which soften about 10,000 gallons an hour for use in the boiler-house.

All the waste waters from the mill, amounting to about 35,000 gallons per hour, are collected and run through 24 settling-tanks and ponds, besides a large filter bed, before being passed into the river, so that there may be no risk of pollution. The total cost of the elaborate system of drains, pumps, pipes, settling-tanks, etc., put in solely with this end in view, exceeded £5,000, and the yearly cost of working them is over £200.

Since 1885 the mill has been entirely lit by electricity. The light is obtained from two of Mather and Platt's "Manchester" dynamos, each of 450 lamp-power, and one Siemens' dynamo of 1,200 lights. There are in the mill about 950 incandescent lamps, of which 120 are 100-candle, and the rest 16-candle power. The dynamos can either be driven from the main shafting or by a separate high-speed Armington-Sims engine; either the two small dynamos together, or the large one alone, being capable of lighting the mill.

Surrounding the whole premises are underground fire-mains,



CALENDERING HOUSE, CROXLEY MILL.

connected with a steam fire-pump which is capable of throwing two tons of water per minute. These, together with a good manual fire-engine, are under the management of a properly-organized fire-brigade.

Croxley Mills, together with the engineering shops attached to them, now give employment to between five and six hundred workpeople, and have an out-turn of 160 tons of paper each week, so that they rank amongst the most important paper mills of the country; while, owing to their size, the number of paper machines, and variety of materials used in them, together with the advantages accruing from direct telephonic communication with London by a private wire, they have on more than one occasion of sudden urgency astonished both printers and publishers by delivering large special makings of paper a very few hours after receiving the order, thus enabling important works to be brought out at the exact hour to meet some national demand.

NASH MILLS.

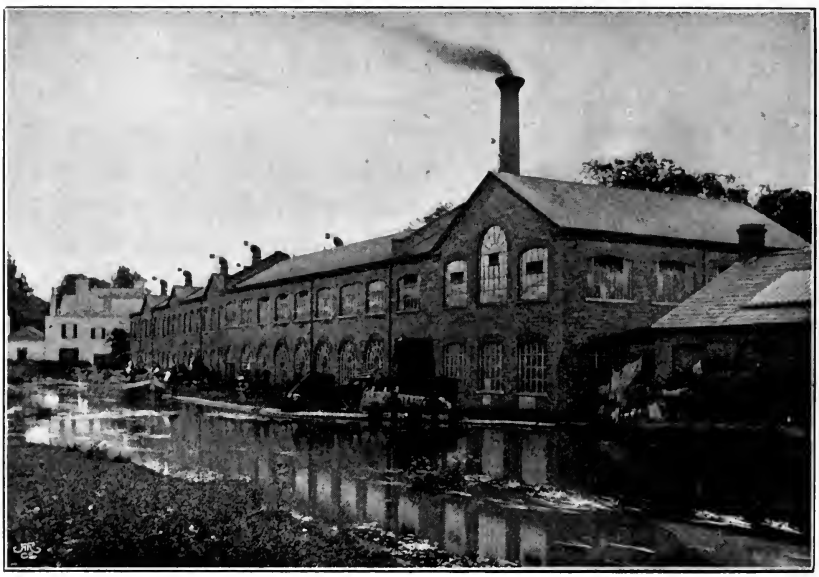
NASH MILLS, which was purchased by Mr. Dickinson in 1811, had already been converted from a corn mill to a paper mill, and amongst the old moulds for making paper by hand, which are still stored in this mill, there are some bearing the following water-marks:

Apsley Mills,	1797, with a fleur-de-lys,
A. Blackwell,	1798,
A. Blackwell and G. Jones,	1801-2,
G. Jones,	1804-10,
Nash Mills G. J.	1807,
J. Dickinson and Co.,	1809-11,

A. Blackwell and G. Jones having been Mr. Dickinson's predecessors. On October 26th, 1813, a considerable portion of the mill was destroyed by fire, and the dwelling-house close by was only saved by hanging wet paper-felts on the walls and roof. The damage done to the mill was estimated at between £7,000 and £8,000.

It was here that Mr. Dickinson, about 1830, erected his machine for making fine plate and duplex papers, a machine which continued in use with little alteration until 1890, when it

gave place to a wider one, made on the same lines. In 1879 the mill was almost entirely rebuilt, "Hercules" turbines being substituted for the old water-wheels, and all the beaters being arranged in one room and on one level, and a new machine-house built. In 1880 the first koller-gang, or edge-runner, used



NASH MILLS.

in this country, was put up for pulping broken paper or waste, and in 1888 one of the paper-machines was driven by an electric motor, being the first time electricity was used for that purpose. In 1894 a further change was made in the mill, two of Mr. Dickinson's narrow paper-machines being removed, and one new machine on the Fourdrinier principle substituted for them.

At this time also the old beam engine, which had worked continuously night and day since 1837, driving the machines, was taken down. The mill, which, in 1838, was making about eight tons of paper a week, in 1893 made thirty tons, and can now turn out nearly fifty.

NASH MILLS FIRE-BRIGADE.

The beater-house at Nash Mills is a nice light room, and—like all the new buildings at Croxley—has a concrete floor, which greatly tends to the general cleanness of the mill. In addition to those of the ordinary type, it contains also four Taylor beaters, the whole being driven by belts from a 5-in. steel shaft running below the floor.

The mill is not a large one, and many of its buildings are occupied by the smiths', carpenters', and fitters' shops in which the machinery for this mill, as well as that for Apsley and Home Park Mills, is made and repaired; so that, as it is shut in between the canal, the river, and Nash Mills House, now the residence of Sir John Evans, there seems no probability of any great change in it; but it has been specially designed with a view to the manufacture of clean plate papers, and as it is also provided with an unusually large number of stuff chests, it is admirably adapted for making all those special papers which form so large a part of its produce.

Nash Mills is the head-quarters of the mills fire-brigade, which was first organized in 1883, when a powerful steam fire-engine by Merryweather was purchased. This was, in 1893, replaced by a new engine of the "Greenwich" type by the same maker, to which has since been added one of Shand and Mason's manual engines. Luckily, the brigade has had but little work to do in extinguishing fires at the mills, but on several occasions it has stopped serious conflagrations in the neighbourhood, and at the various friendly competitions it has attended has invariably carried off either a first or second prize.

APSLEY MILL.

THIS mill was formerly a corn mill belonging to the Abbey of St. Albans, but it had already been converted into a paper mill when Mr. Dickinson bought it in 1809, and under his control it quickly developed into a very important mill; in fact, Mr. Hassell, writing in 1819, says of the mills, "These within a short period had been considerably enlarged, occupying a large space of ground, and rather resembling a village than a manufactory."[1]

Very little of the old paper mill that Mr. Dickinson bought is now standing unaltered, but there are still two of the old drying lofts in which the wet sheets of hand-made paper used to be hung up to dry. Steam power was first introduced into the mill, and probably into the paper trade, by Mr. Dickinson, who put up three paper machines here; but the number of work-people in the mill in 1823, when Colonel P. Meadows Taylor came to take charge of it, was only about forty. In 1833 a new paper machine was substituted for two small ones, and another change was made in 1848-50, when a new machine-house was put up, and a new machine, complete with air-drying drums for

[1] "Tour of the Grand Junction Canal," by J. Hassell, London, 1819.

making tub-sized papers; this machine was further improved in 1864-5, so as to make good writing and envelope papers, and the other machine was similarly improved in 1877. The mill was making about nine tons of paper each week in 1838 and rather more than double that quantity in 1888, when the paper manufacture at Apsley was finally stopped, and all the machinery connected with it removed, including the fine old beam engine of 40 horse-power nominal, which had been put up there in 1844 at a cost of about £3,000. The manufacture of cards was first introduced at Apsley about 1831, but the quantity made had only reached eight or nine tons a week when, in 1883, a new card factory was built, and ever since there has been a steady increase in the output, which is now nearly fifty tons a week, and comprises all kinds of cards, Jacquard loom cards, and pasteboards, varying in quality from the finest ivory visiting cards to common pasteboards, and in size from the largest mounting boards to railway tickets.

Envelope making, which was introduced at Apsley in 1850, had greatly developed in 1876, but only three million envelopes were then made each week, and it was decided to build a special fireproof building, 160 ft. by 30 ft., with three floors, to accommodate the valuable machinery used for making them. This building was opened on May 1st, 1877, by a dinner given to all those working in the mill, when over 600 sat down. The envelope machines have again outgrown this building, and now occupy much of the space formerly taken up by the paper-making plant, the remainder being occupied by various branches of the work, such as black bordering, die stamping, printing, box making, gumming, cutting, and the folding by hand of special sized envelopes, the making of fancy stationery boxes, and cabinets.

ENVELOPE ROOM NO. 2.

The modern envelope-making machines, after nearly fifty years of constant development, are indeed most wonderful and complex pieces of mechanism, by no means easy to understand or describe; but the general system on which they work is somewhat as follows: The paper "blanks," which are punched out of the large sheets of paper a hundred at a time by shaped cutters, are piled up on the feeding-table of the machine; then two "pickers," one shaped to fit the nose- and the other the tail-flap of the envelope, which have been covered with gum on their lower face by an indiarubber-covered gumming roller, fall on to the top blank of the pile, which sticks to the wet gum and is removed from the rest when the pickers are lifted up again. As they rise with their light burden a frame slides out under the blank, ready to take charge of it immediately that it is separated from the pickers by coming in contact with a fixed stop-plate; and before the pickers fall again to fetch another blank, the sliding frame has moved out of the way and brought its charge exactly over a rectangular folding-box, into which the gummed blank is then driven by a falling plunger, which thus shapes the envelope to the exact size required. As soon as the plunger has been withdrawn four hinged folders come into action, which fold over the flaps and complete the envelope, and it then falls through a kind of trapdoor below the folding-box into an endless chain-rack, which is so contrived that while the tail-flap is pressed down on the envelope so that it may stick securely, the nose-flap is held just clear of the envelope, which is then carried round by the chain in this position until the gum on it is dry. By that time the envelope has come back almost to its starting-point, and it is then taken from the chain by two lever arms and placed with the finished envelopes in a long trough. By a clever counting

arrangement each twenty-fifth envelope is placed a little on one side, so that the girl in charge of the machine has only to put a paper band round each twenty-five envelopes as the machine delivers them to her. Even this light task of banding is performed by some of the machines automatically, and they will even print addresses on the envelopes at the same time.

It would need much time and space to describe all the machines now used in this branch of the business; their number and variety may, however, be estimated when it is remembered that envelopes of all sizes, shapes, and substance are made, and that many of them have printing, stamping, and black-bordering work connected with them. There is also one part of the mill devoted entirely to miscellaneous stationery work, such as machine ruling, note paper cutting and packing, account book making, post card printing and perforating, with all the other collateral manufactures required in a large stationery factory. The paper store rooms connected with this mill were already large, but an additional building, 180 ft. by 90 ft., has just been built to supplement them, and to keep the mill in a fit condition to cope expeditiously with the orders that flow in from all parts of the world.

This mill now gives employment to about 1,000 people, and more than 150 tons weight of cards, envelopes, and stationery are sent out from it each week.

ENVELOPE ROOM NO. 3, APSLEY MILLS.

HOME PARK MILL.

HOME PARK MILL is so named from its situation within the confines of the park that was attached to King Henry III.'s palace at King's Langley. This mill was built by Mr. Dickinson in 1825, and enlarged in 1838, at which date it turned out ten tons of paper each week. About the year 1843 Mr. Dickinson chose this mill for a paper-staining and enamelling factory. In 1864 a fourth paper-machine was added to the mill, and in 1878 the first colouring machine was put up, prior to which time all the paper-staining had been done by hand. In 1883 this machine was destroyed by a fire, which did about £1,000 worth of damage, but this was soon made good, and the colouring works further developed by the addition of a new building with two machines in it. The mill underwent an entire change after 1888, in which year it was finally closed as a paper mill, and the space thus set free was utilized in 1890 by building a large colouring mill of three floors, and substituting turbines for the old water-wheels which had previously driven the machinery. At the present moment, besides the hand colourers for special work, the mill is equipped with eight colouring

machines, turning out all kinds of chromo, enamelled, coloured, and art papers and cards.

The colouring machines are made to colour paper of any length on reels as it comes from the paper machines. The process is as follows : A web of paper passes under a large metal cylinder,

HOME PARK MILL.

and as it is carried round on it has first the colouring matter applied to its surface either by a circular brush or by an endless felt working in a trough of colour. It next passes a fixed brush, which distributes the colour more evenly, and then a series of brushes moving from side to side, which complete the distribution. The wet paper with its coloured side uppermost then goes over a light fast-running wooden drum, which draws it away from

the top of the colouring cylinder; the paper hangs slack beyond this drum, but before it can reach the floor it is caught up by a round stick carried at each end on projecting links in two endless inclined chains, which carry both stick and paper almost to the top of the room, where the stick is transferred to horizontal chains which

HOME PARK MILL.

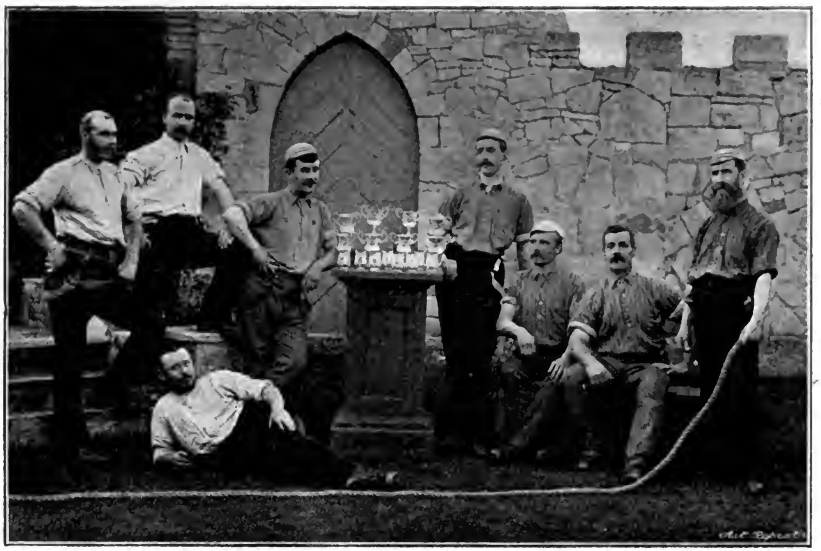
move slowly forward in grooved wooden guides. The projecting links on the first pair of chains then descend and pick up a fresh stick from the bottom of a box in which they are piled one above the other; this second stick in its turn picks up the wet paper once more, and is carried up to the top chains, where it arrives when the first stick has moved away about a foot. By this means the web of wet coloured paper is hung in festoons from stick to stick,

and these by the slow movement of the top chains are carried gently to the end of the drying-room. When they reach the end they pass round a sort of turn-table, and then come back again alongside of their previous course, until by the time they arrive at their starting-point the colour is dry. The coloured paper is then wound up again in reels, and the sticks which had carried it fall down shoots into the stick-box from which they started, and are ready for use once more. After this the paper has to be glazed and cut up into sheets by machines similar to those used in ordinary paper mills.

Though the mills were all established before the age of railways, Mr. Dickinson with his usual forethought chose for his enterprise a locality provided with excellent water-carriage, and though the London and North Western Railway now passes close to three of the mills, and one of its branch lines near to the other, water-carriage is still found to be the cheaper and cleaner, so that the greater part of the traffic of all the mills is even now carried on by means of the Grand Junction Canal, on which there are quite a fleet of boats employed in bringing coal and materials to the mills, and in taking away paper and stationery. These boats each carry about twenty-five tons at a time, and every evening paper leaves the mills by them, and is delivered in London next morning at six at the company's warehouse, Irongate Wharf, Paddington. Furthermore, the whole mill system is closely knitted together by a private telephone service, which also connects them with the London office at 65, Old Bailey, and thus brings them into touch with all the markets of the world.

With a view to encouraging healthy exercise and recreation amongst those who work in the mills, a field was taken by the

Company near Croxley Green, which has been enclosed and prepared as a cricket and football ground; while, in order to secure proper intellectual recreation, the "Dickinson Institute" has been recently started in the same village, and has proved to be most remarkably successful. It not only provides classes,



TUG-OF-WAR TEAM, CROXLEY MILL.

lectures, concerts, and social entertainments, but, in addition, combines with them all the other advantages and amusements of a club and library. Besides this, there is in the village a prosperous co-operative store, which was established some years ago in one of the houses belonging to the Company, and which is steadily gaining ground, and will before long be compelled to seek larger premises. So that during the last few years Croxley

Green village has not only largely increased in population, but it has also developed in other ways, and is now provided with most of the institutions necessary for the prosperous village community that it now is. With the same objects in view the cricket and football clubs near Nash, Home Park, and Apsley Mills are also helped and encouraged, as well as a cricket club and a cycling club that have been organized in connection with the London House. At Apsley, also, an excellent brass band has been formed amongst those connected with the mill, the instruments for which were provided by the Company. This band was only started in 1894, but, very greatly to the credit of its members, it has already earned for itself a good reputation in the neighbourhood.

The Company also subscribes largely towards the expenses of an excursion to the sea-side which takes place each year in July, and which is open to all those employed in any of the mills; so that there are many influences at work to encourage that friendly feeling which existed between the members of the late firm and those who worked for them—a feeling which has been carefully maintained and developed by the Directors of the Limited Company, with the result that the whole business is now permeated by a spirit of union and loyalty which is an absolute guarantee for its continued progress in the future.

Ancient Paper-Making.

A LECTURE

GIVEN AT THE DICKINSON INSTITUTE,
CROXLEY MILL,

By MR. LEWIS EVANS,

ON THURSDAY EVENING, FEBRUARY 27TH, 1896.

Ancient Paper-Making.

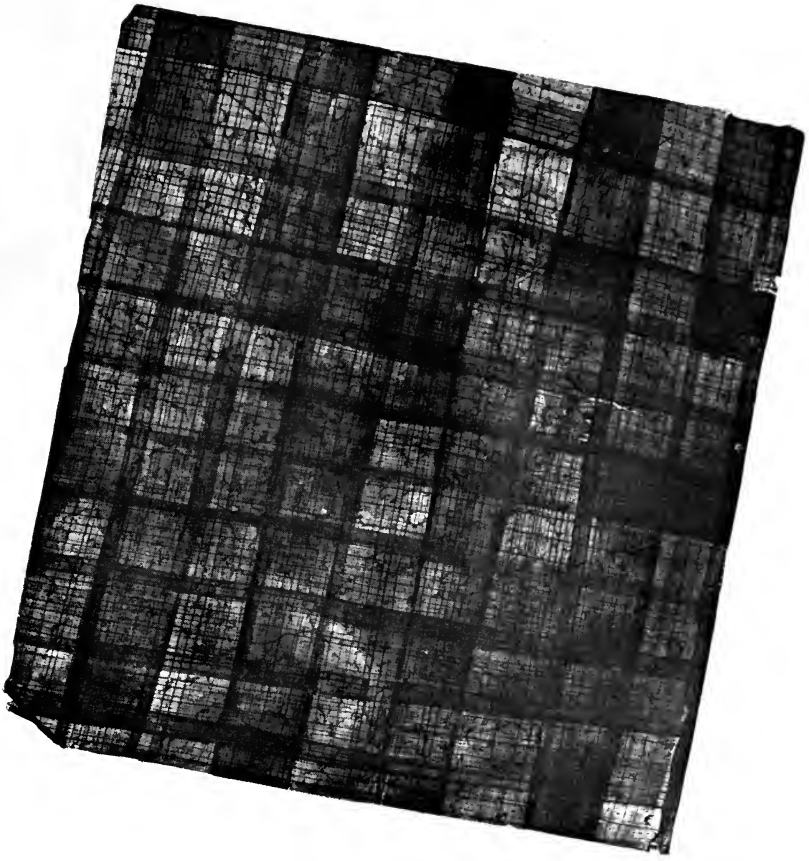
I INTEND this evening to confine myself entirely to matters connected with Ancient Paper-making; but although it is quite obvious at what date modern paper-making began, namely, in 1830, when Croxley Mill was started—a veritable epoch-making event in the history of paper—it is by no means easy to say within some centuries when paper was first made, unless we give the wasp credit for its discovery. However, as I am now dealing with matters of history rather than natural history, and the wasp after all only made paper-hangings to put round his house, and declined to part with them to the public on any reasonable terms, I will for the present put his claims on one side.

Of course we know that before paper was used there were numerous other substances which to some extent filled its place, and we find records in hieroglyphics and writing on rocks, stones, metals, wood, etc., still extant in many parts of the world, which were made centuries, if not thousands of years, before the time at which we have the earliest traces of paper. I imagine that in the childhood of mankind, as in the childhood of men now, the earliest attempts at writing were made with a bit of stick on sand or mud, and that the employment of more stable materials, such as rocks and stones, bones, ivory, metals, and wood, together with that of skins, the bark of certain trees, such as the lime and birch, with the leaves of palms and some other plants, followed in

a natural sequence. I am able to show you some modern documents from Burmah, written on the leaves of palm trees with some pointed instrument, while it is within the knowledge of all of you that the custom of writing on the bark of trees with such instruments still exists in this country, though the records made are usually limited to some initials in a heart.

The first artificial substance used to any great extent to write upon was papyrus. This wonderful material, which is known to have been in use as early as 3,700 years B.C., and therefore claims an antiquity which it is almost impossible for us to grasp, continued in use as the staple writing material of the civilized world for nearly 5,000 years. It was made from the inner bark of an Egyptian river plant, which had a triangular stem some twelve feet high, covered with a laminated bark consisting of about twenty different films. These were stripped off, cut into lengths, and laid out singly side by side on a flat surface, so as to make up the size of sheet required. This first layer was wetted with starch or gum, and on it a second was placed, crosswise, and the sheet, after pressing or beating, was dried and smoothed with a stone or some hard substance. About the year 200 B.C. the Ptolemy of the period tried to prevent the export of papyrus from Egypt, and Eumenes of Pergamus, in Asia Minor, who wished to form a library to rival the celebrated one at Alexandria, had to seek some other substance on which to make his books. Under his auspices a great improvement was made in the preparation of skins for writing upon, and this improved material was known as *Charta Pergamena* from the town of its origin, and hence its present name, parchment. The manufacture of papyrus was established at Rome about the Christian era, and the Roman product was both whiter and better than the Egyptian, as it was sized with flour and its layers beaten together by a hammer. It was made in several qualities, the best of which was called *Charta Hieratica*, a name adopted by a stationer of our times for a very different kind of note paper.

A somewhat similar writing material was also made by the Romans from the inner bark of trees, which was treated like the films of the



SHEET OF PAPYRUS, SHOWING THE WAY THE FILMS CROSS EACH OTHER.

papyrus, save that it had to be made in three layers, and was thicker, not so white, and more brittle than papyrus. It is interesting to note that while the Latin word for this bark, *liber*, became in that language the word for a book, and remains with us in "library," the Greek name for papyrus, βύβλος or βίβλος, is perpetuated in our word "Bible," and papyrus has given its own name to "paper."

I am unable to give you the date within a thousand years or so of the specimens of ancient papyrus that I am handing round; but if you hold them up to the light, you will see clearly the crossed layers that I have described. The papyrus plant is said to be extinct in Egypt, but it still grows in the island of Sicily, from which my specimens of the plant and modern papyrus paper were brought, the latter being identical in appearance and manufacture with the ancient specimens.

While these materials, supplemented for common purposes by tablets of wood or metal covered with wax, on which the writing was scratched by pointed styles of metal, bone, or wood, were used in the West, the Chinese in the far East had for a long time been making paper direct from cotton and some other vegetable fibres, which they boiled and beat up by hand in mortars with water to a fine paste, and formed into sheets on bamboo moulds. The knowledge of this coarse cotton paper came through Tartary and Central Asia to the Greeks about A.D. 600, and from them through Venice into Germany, where, in the 9th century, this coarse cotton paper was known as Greek parchment. This same knowledge came through the Arabs and Moors into Spain when they invaded it in the 8th century, and they established paper-mills there soon afterwards, and the manufacture then gradually extended over Europe.

The earliest papers were made direct from cotton or some other fibrous substance. The 12th century paper now before you was made in that manner, and it is quite uncertain when the manufacture of paper from rags became general; probably their use was kept as a trade secret for years, or even centuries, after their first introduction. It seems likely that cotton rags were first used about the year 1100, and hemp or linen rags perhaps a century later. Originally these materials

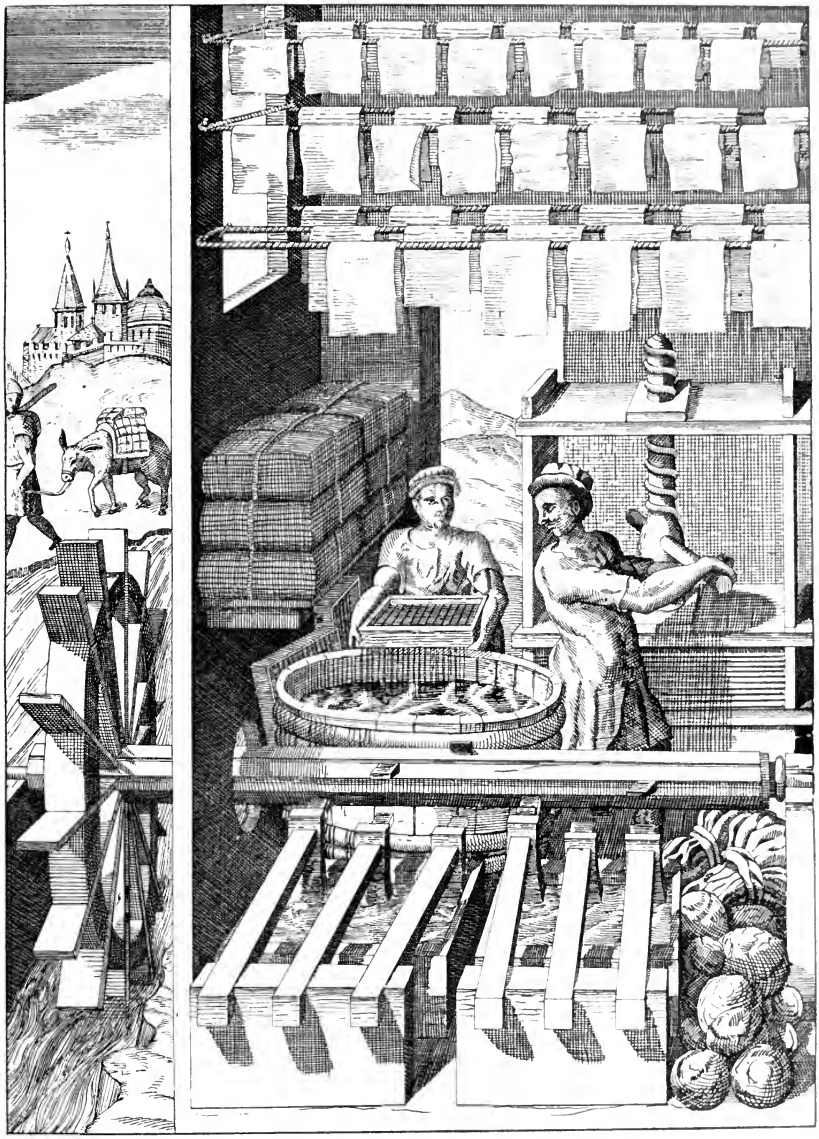
were pounded into pulp by a pestle and mortar worked by hand. This primitive "beating engine" was succeeded by the somewhat similar stamping-mill shown in the diagram, which I have copied from a German book on machinery by Böckler, dated 1662. You will see in the foreground a set of these pestles or stampers, which are raised by projecting pallets on the revolving shaft, and allowed to fall by their own weight. The Spaniards are supposed to have invented this kind of mill about the 12th century.

Naturally, until the invention of printing, there was comparatively little demand for paper, and it was not until the end of the 15th century that any white paper was made in England, though possibly coarse wrapping paper may have been made here at an earlier date. To us inhabitants of Hertfordshire it is a great satisfaction to know that the first English paper-mill was Sele Mill at Hertford, where John Tate the younger, a son of a John Tate who was Lord Mayor of London in 1496, made the first white printing paper. This fact we know from a book, "De Proprietatibus Rerum," printed by Wynken de Worde, one of our earliest English printers, in 1495, in which occur the following lines:

> "And John Tate the Younger joye mote he broke
> That late hath in England do make this paper thynne
> That now in our Englysh this boke is printed inne."

This mill of Tate's was a great curiosity, and when Henry VII. stopped at Hertford Castle in 1498, on May 25th he visited the mill, as is shown by an entry in his household book, which still exists, and under that date has an item "for a rewarde geven at the paper mylne 16/8." There is also one in the following year, "geven in rewarde to Tate of the Mylne 6/8."

These sums do not now sound very large, but people were not so well off in those days, and a sheep only cost about 1*s.* 6*d.*, while a week's wages for a man were from 2*s.* to 3*s.* We housekeepers might probably be glad to see mutton again reduced to the old rate, but I do not think a similar reduction in wages would be cordially welcomed at Croxley Mill.



COPIED FROM G. A. BÖCKLER'S "THEATRUM MACHINARUM,"
FOLIO, NUREMBERG, 1662.

It is a remarkable thing that so useful a manufacture as paper should ever die out of a country after it had once been established. Nevertheless, this seems to have been the case in England, for in 1588 a paper-mill was put up at Dartford, in Kent, by a German—Spilman or Spielman—which is often considered to have been the first English paper-mill, and for the institution of which Spielman was knighted by Queen Elizabeth. Mr. Spielman seems in some respects to have been more ambitious than our modern paper-makers, as he managed to combine with his mill the business of jeweller to Her Majesty, by which title he is described in his patent, which was renewed in 1597 for fourteen years. In 1601 and 1602 he won lawsuits that he brought to stop two paper-mills that had been started in Buckinghamshire. Probably it was about this time that Shakespeare wrote his play of Henry VI., from which the quotation in the prospectus of your Institute is taken. Jack Cade, addressing Lord Say, says, "And whereas before our forefathers had no other books but the score and the tally, thou hast caused printing to be used; and, contrary to the King, his crown and dignity, thou has built a paper-mill."—Part II., act iii., 7. Jack Cade's rebellion occurred in 1450, so that Shakespeare here seems to commit an anachronism, or, as the Americans say, to have been a little too previous; but Cade's rebellion was chiefly backed by the men of Kent, and Spielman's new paper-mill at Dartford, in that county, and his lawsuits, were doubtless matters of common talk at the time, so I think that this is rather what we now call a topical allusion, and was intended to apply to Spielman's mill, the topic of the day.

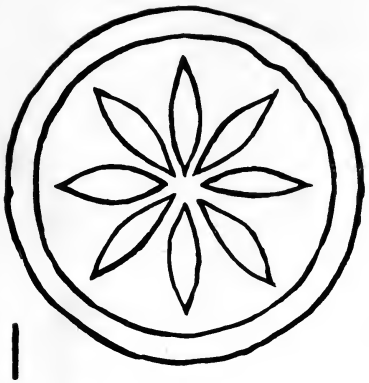
Possibly the combination of jewellery and paper did not prove to be a financial success, as paper-making seems again to have died out of the country, and in 1641 Endymion Porter, Captain John Reade, Edward Read, and John Wakeman got a fourteen years' patent for the *invention* and manufacture of white writing paper. These gentlemen seem also to have met with but little success; partly no doubt on account of the civil war, though they also had other difficulties to contend with, as, owing to the prevalence of the plague and the risk of contagion through rags, the inhabitants of Bucks and Middlesex objected

to having paper-mills in their counties, and in consequence some mills had to be closed, and the trade languished or died out for a third time. We find, however, the following notice inserted in a book published in 1678:

"To the King's Most Excellent Majesty this book is humbly presented, being printed upon English Paper, and made within 5 miles of Windsor by Eustace Burneby, Esq., who was the *first* Englishman that brought it into England."

So that for a fourth time paper-making was started in England about the year 1678.

From this time on it seems to have thriven. The influx of Huguenot refugees into the country in 1685 brought over many skilled paper-makers, but still at the end of the century there were under 100 mills in the country, and they must, for the most part, have been small one-vat mills, as even so late as 1721 the total make of the country was only 3,600 tons, or rather less than half the present make of Croxley; and in 1800 the make of all England was just about the same as that of Croxley now is, or about 8,000 tons a year. One reason why the make of paper did not increase more rapidly was the difficulty in finding materials from which to make it; and the supply of rags not being sufficient for the purpose, we find in the middle of the last century many attempts were made to discover suitable substitutes. In 1751 M. Guétard, in France, produced specimens of paper made from the leaves, bark, and wood of certain plants and trees. In 1756 an attempt was made in Germany to use straw for paper-making, while in 1765 Jacob Christian Schaffers, of Ratisbon, published a book, in which he showed samples of paper made from the following materials: Asbestos, cotton grass, thistle stems and down, burdock, lily of the valley leaves, water weeds, peat, mallow, pinewood, maize, wormwood, vine stems, broom, fir cones, potato plants, reeds, the leaves of chestnut, lime and nut trees, refuse from dye woods, such as fustic and logwood, wasps' nests, sawdust, wood shavings, beech, willow, aspen and mulberry wood, tree and earth moss, hop vines, hemp waste, aloe leaves, clematis, stinging-nettles, willow bark, straw, and leaves of trees. Unfortunately the chemical knowledge of those days was insufficient, and none of



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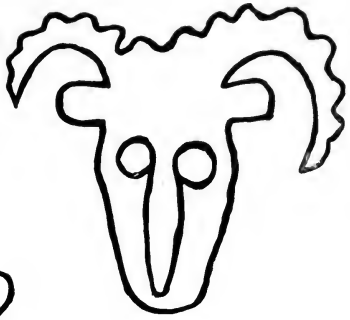

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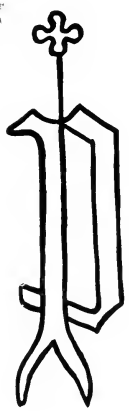


6

WATER-MARKS IN PAPER.

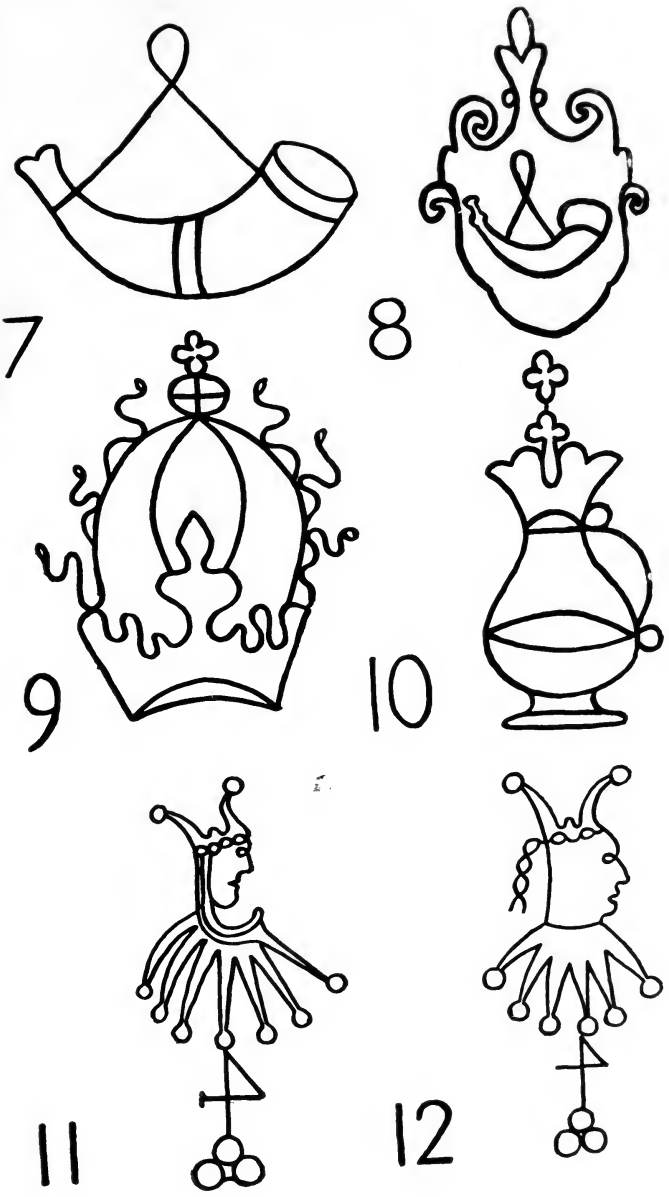
these materials in Schaffer's hands produced any useful white paper, as you will see from the samples in the books before you; and it was not until after the discovery of chlorine by Scheele, in 1774, that any useful white papers were made from other materials than rags. The first attempt that met with any degree of success in this country, or, I believe, in any other, was one made in 1800 by Matthias Koops, who, at Neckinger Mill, Bermondsey, succeeded in making a tolerably good yellowish paper from straw, rather a better one from wood, and a very fair sheet from old written and printed papers. He patented his process, and published two editions of a book about the history of paper in 1800 and 1801, which were both printed on his productions—the first is on a paper made entirely from straw, and the second on one made from old papers, while each has an appendix printed on wood paper, all, as you see, very decent papers. But neither straw nor wood came into general use for paper-making until about 1860, when they, together with esparto and various other fibres, began to be extensively used as substitutes for rags. All through the last century paper-makers were greatly hampered for want of materials, and when an Act of Parliament was made forbidding, under heavy penalties, the burial of people in linen grave-clothes, though this law was primarily intended for the benefit of the woollen industry, it was considered also a great benefit to paper-makers, as they estimated that it prevented about 110 tons of linen from being put away each year in the ground, which they now hoped to see in their mills.

I wish now to turn to another aspect of paper-making, and, perhaps, I should call this the Art of paper-making (with a big A). I mean that of water-marks. You will see two diagrams of water-marks before you, about which I have something to say. The earliest water-mark is said to be in the form of an orb and cross, and in paper made in 1301. This I have not shown, but No. 1, a kind of cart-wheel or star in a double circle, is the water-mark used by John Tate, our first English paper-maker, the Hertfordshire man, in 1494. No. 2, a ram's head; No. 3, a parrot; No. 4, a wivern, dated respectively 1330, 1354, and 1378, were from papers made in the south of France. No. 6, a black letter P. stood

originally, in 1347, for Duke Philip of Romiere, and is found in the paper of the first books printed in this country by Caxton. This individual mark is copied from a sheet of paper dated 1461. No. 5 is a hand with a heart on it, from a sheet made in Holland or Germany in 1578. These water-marks, which were originally makers' marks or trade-marks, in time became associated with sheets of a certain size, and probably the designation small-hand took its origin from some such mark as this. Similarly No. 7, on the other diagram, a post-horn, dating about 1431, from the south of France, is clearly the same as No. 8, a horn in a shield, from a Dutch paper of the year 1723, and both are ancestors of the horn-mark of our modern post paper, while No. 9, a crown, 1616, and No. 10, a pot, 1542, both Dutch, show the origin of crown and pott, now used as names of a definite size of paper. The two foolscaps, No. 11, 1605, and No. 12, 1701, speak for themselves as Dutch representatives of a mark dating from 1479 or earlier, now superseded in this country by the figure of Britannia. Nos. 5, 6, 8, 9, 10, 11, 12 are from sheets of paper in my own collection, the rest are copied from other sources. All of them are simply enlarged from the originals without change or improvement; and I hope you will credit me with being able to draw rather better than that when I am left to myself.

Before we leave water-marks I will show you a sheet of hand-made paper with a well-known water-mark in it, dated 1810, about the time that Mr. Dickinson supplemented the old hand methods of paper-making by his newly-invented paper-making machines.

Now as regards the making of paper. I showed you just now some specimens of papyrus, and explained how that was made. What I now exhibit is a modern paper or felted fabric made in Fiji or Samoa from the inner bark of a tree, by laying pieces side by side, and hammering and manipulating them while moist, until they become one homogeneous sheet. When stamped with coloured patterns this material is known by the natives as tapoo cloth, and was, I believe, until recently the only clothing of South Sea islanders. The early papers made from the bark of trees and from raw cotton were probably made in a similar way, by hammering and manipulating on a flat surface when moist; but later,



WATER-MARKS IN PAPER.

and especially when rags were used, they had to be reduced to a pulp, at first by hand, with a pestle and mortar, and in later times by stamping-mills like that shown in the diagram and in the books I am handing to you. In order to make the rags pulp easily, they were first thoroughly wetted and then squeezed up into balls and kept moist until they heated and a kind of fermentation took place, which had somewhat the same effect on them as the modern method of boiling with soda has. This system of fermenting or retting was in the last century most carefully studied, the rags being treated in large quantities, stacked in heaps, and turned and moistened from time to time; the whole treatment sometimes taking as long as six weeks. The stamping-mills were also developed from the crude form shown in the diagram, until a good mill consisted of as many as six pans, each containing three stampers.

All the pans were lined with iron or brass, and the stampers in the first three of them were shod with sharp, coarse nails, to tear or break in the rags, while a stream of clean water ran in to wash them, the dirty water escaping through a grating covered with horse-hair cloth. When sufficiently broken in, the contents were baled out and put in the next two pans, whose stampers were shod with finer nails, where washing still went on, and the rags were beaten fine; the beaten pulp was then again taken out and placed in the last pan, to be refined or cleared by stampers of plain wood; the whole process of beating taking from twenty-four to thirty hours. A certain amount of circulation was kept up in the pans by making each of three stampers have a slightly different length of stroke. A stamping-mill of this size would make five or six hundred-weight of paper a week.

Early in the last century an improvement on this method of beating was introduced by the Dutch, who required a machine that took less power, so as to be adapted to the windmills, on which they had to rely for their driving power. This new invention was a revolving roll with knives on it—in fact, the present "beating engine," which became known all over Europe as the "Hollander," from the country of its origin. I do not know exactly when it was invented, but probably about 1720, as in

a Dutch book that I have on machinery, dated 1734, it is drawn without any special explanation or comment as to its novelty.

The "Hollander" was found to take one-third of the time and beat better stuff, and two of them, taking the same power as an old stamping-mill, would turn out three times as much paper, besides costing less for repairs.

The pulped rags were next transferred to a tub or vat and had a quantity of water added, so that the mixture was quite thin. The vatman then took his mould, a kind of sieve made of straight wires laid closely side by side, bound to each other at intervals with fine wire. Under each line of binding wire was a wooden bar, which supported the wires; this had a sharp edge next the wire, so as not to interfere with the flow of water from the mould. On this mould a loose wooden covering-frame fitted, which projected a little way over the wire all round the mould, as you see in this old specimen, which bears the name of G. Jones, 1806, the paper-maker who had Nash Mills before Mr. Dickinson. It is the right size for demy, and has the fleur-de-lys water-mark, which belongs to that size of sheet.

The German and Dutch name for a cover is *deckel*, which name was adopted in this country for the paper-mould covers, perhaps from Spielman's German workmen, and is now also used to denote the india-rubber guides that regulate the width of the paper on a machine, so that the natural rough edge of any paper is called the deckle edge.

The vatman takes his mould, dips it in the vat full of pulp, and bringing it out again horizontally, with a layer of pulp on it, gives it a peculiar shake to lay the fibres evenly, and the water running away through the wires of the mould, a sheet of paper is formed on the surface. This sounds easy, but in reality requires years of practice to do well. He then lifts the deckle off the mould, which he slides across some bars on the vat towards the "coucher," who hands him another mould in exchange. The "coucher" leans the first mould against a support to drain, while he lays out a piece of felt rather larger than the paper. He next takes the mould, turns it over on the felt, and, lifting it up again, leaves the sheet of paper lying on the felt. He then exchanges his

empty mould for the full one, which the vatman has prepared for him, and so on. This process is called "couching," and the word is taken from the French *coucher*, to lay, and is also used to describe the removal of the paper from the wire in paper-machines.

Until about 1755 all paper was made on moulds in which the wires were laid side by side, but Baskerville, the great Birmingham printer, wishing to get a smoother paper, got a maker to have some moulds covered with woven wire cloth, and in 1757 he published an edition of Virgil, printed for the most part on this paper, a copy of which I have here. This explains the origin of the trade names "laid" and "wove," as applied to paper.

There is a story that no colouring matter was used for brightening the tint of papers until one day, when a paper-maker's wife had gone down into the vatroom to do her washing in a disused vat, she somehow managed to drop her bluebag into a vat full of pulp. After fishing about for it with a stick for some half-hour, she at last got it out, and said nothing about it. Her husband could not think what had happened when he worked the stuff out, and the wife—why, of course, the wife held her tongue. However, the paper-maker determined to make the best of a bad job, and next time he went to market took his blued paper with him to try to get rid of it, and by making a great song about its beauties, managed to get an extra twopence a pound out of a stationer. Pleased with his luck, like a good husband he bought a new dress for his wife, and when he gave it her told about his success with the spoilt paper. Whereupon she confessed what had happened, and he began to use a bluebag for all his papers. This is the story, and probably the husband's version of it, but anyway, about a hundred years ago people began to put a great deal of blue into their papers, and make them of a very ugly dead green colour.

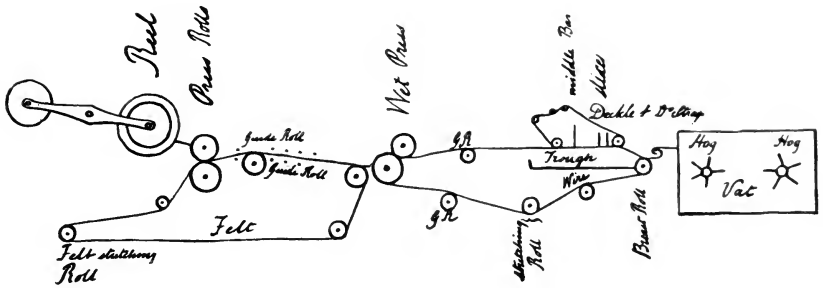
But to return to the paper-makers. Improvements were made in the vats from time to time, mechanical agitators were fitted to them to keep the contents stirred up, and a charcoal heater was put in the side to warm the pulp and make it work better, as you will see in these engravings, which are copied from French plates of 1698.

When the coucher had some six or eight quires of paper between felts in his heap, they were taken away and put in a powerful screw-press. After this the sheets were taken from between the felts, piled on each other and lightly pressed; they were then parted and hung up to dry four or five together over horsehair lines. When dry they were taken down, and sized by dipping them in a tub full of size made from raw hides, hence our modern term "tub-sizing;" they were again dried and pressed for some twelve hours to flatten them.

Glazing was done either by pressing and relaying the paper several times, by hammering with light hand or heavy tilt-hammers, or by rubbing with a polished flint; but the Dutch seem to have used a pair of glazing rolls about the time that they introduced the Hollander beating engine.

These were the methods employed in paper-mills in this country for more than three centuries; but in 1798 Louis Robert, a workman employed by François Didot at Essonne, devised a plan for making paper in endless webs, which he succeeded in doing experimentally some time in 1799 and obtained a patent for fifteen years, but owing to the disturbed state of France, the invention was brought over to England and patented for Robert by John Gamble. Several improvements were patented during the next two years, and in 1803 Mr. Bryan Donkin completed a machine which worked fairly well. Messrs. H. and Sealy Foudrinier bought the patents of Robert's machine, which thenceforth was known by their name, and in 1804 the first paper-machine that made marketable paper was put up for them by Donkin at Frogmore Mill, Two Waters, in this county—another paper-making triumph for Hertfordshire. This machine had two webs of wire, one over and one under the paper, but in the following year Mr. Donkin got it to work with the lower one only. Messrs. Foudrinier spent £60,000 in trying to improve the machine, but had not made any great success with it nor sold many, when in 1808 Mr. Dickinson invented his machine for making paper on a cylinder covered by a wire cloth; this he patented in 1809, and soon made into a useful machine. It was not until 1815 that the first paper-machine, on a commercial scale, was started in France. All

Paper-Machine. Apsley Mill.



P. M. Taylor. 1823

the early machines were very imperfect, there being no suction under the wire, the paper being wound up wet, cut into sheets, and dried on lines in the old way. Drying cylinders were introduced in 1821. You see in the diagram a drawing of a machine at Apsley Mill, taken from a rough sketch made by Colonel Meadows Taylor in 1823. You will notice that there are no suction-troughs under the wire, no strainers for the pulp, and no drying cylinders; but, nevertheless, I think it is so nearly like a modern paper-machine, and its date is so nearly that of the starting of Croxley Mill, that I am beginning to trespass on modern times, and must therefore with this conclude my remarks on ancient paper-making.

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